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ABSTRACT

This unit is designed to help vocational agriculture teachers incorporate information on soil formation and the soils geography of Missouri into their curriculum. The unit consists of: (1) a topic outline; (2) general unit objectives; (3) discussions of processes and factors of soil formation, the soils geography of Missouri, and some soil conservation practices; (4) lesson plans for these three topic areas (each plan consisting of a list of materials needed, a list of objectives, and instructional strategies); (5) a glossary; (6) a bibliography and sources of additional information; and (7) appendices. The appendices include overhead transparency masters, a corssword puzzle, a unit test (with answers), a list of Basic Essential Skills Test objectives (for reading/language arts, mathematics, and government/economics) covered by the unit, and lists of conservation education consultants and outdoor skills education specialists in Missouri. (JN)

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Instructional Unit

SOIL FORMATION AND DISTRIBUTION IN MISSOURI

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Conservation Education Series

Conservation education encompasses all the activities and experiences which result in learning about people's dependency upon and use of natural resources to satisfy their needs and wants. Since 1941, the Missouri Department of Conservation has supported a *formal education program* through Missouri's public and nonpublic schools. This formal education program is being expanded with the development of the *Conservation Education Series*. The series will include instructional units designed to aid teachers in their efforts to integrate conservation concepts into appropriate junior and senior high school curricular areas.

The development of the *Conservation Education Series* is a formidable challenge involving many individuals. We are indebted to Director Larry R. Gale and Assistant Director Allen Brohn for their support and encouragement. We are also indebted to Donald K. Heard, superintendent of education, and Al Palladino, assistant superintendent of conservation education, for their guidance and assistance.

This series would not be possible without the contributions of each instructional unit's author and artist. Thanks to Elaine Callaway, conservation education projects coordinator, and Rodney Green, conservation education consultant, for their editing and production efforts.

The *Conservation Education Series* is dedicated to the Department's conservation education consultants, past and present. This small group of men and women have recognized education as a vital and important force in resource conservation...and have accepted the challenge. The conservation challenge should concern all of us, but especially those charged with educating today's youth. We hope this series will aid Missouri teachers in meeting this challenge.

For additional information on conservation education programs, write the Education Section, Missouri Department of Conservation, P.O. Box 180, Jefferson City, Missouri 65102.

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How to Use this Instructional Unit

The *Soil Formation and Distribution in Missouri* Instructional Unit is designed to help vocational agriculture teachers incorporate information on the soils formation and soils geography of Missouri into their curriculum.

The instructional unit includes three sections. Section one explains the processes and factors of soil formations. Section two discusses the soil geography of Missouri. Section three briefly comments on some soil conservation practices. In addition, lesson plans, a glossary, a bibliography and sources of audio-visual materials are provided. This unit also addresses the following Basic Essential Skills Test (BEST) objectives:

Reading/Language Arts #12, 13, 14, 15, 17, 21
Mathematics #3
Government/Economics #7, 8, 10

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Topic Outline

I. Introduction
- A. Purpose of the Unit
  - 1. Description of soil forming processes
  - 2. Distribution of Missouri soils
  - 3. Soil conservation
- B. Soil forming factors
  - 1. Parent material
  - 2. Climate
  - 3. Topography
  - 4. Time
  - 5. Biology
- C. Objectives of the Unit
- D. Importance of soil
  - 1. Food and fiber production
  - 2. Building foundation
- E. Components of soil
  - 1. Materials
  - 2. Organic matter
  - 3. Air
  - 4. Water
- F. Soil boundaries

II. Soil Forming Processes
- A. Physical conditions
  - 1. Parent material
  - 2. Topography
  - 3. Temperature
- B. Chemical conditions
  - 1. Precipitation
  - 2. Carbonic acid
  - 3. Dissolved minerals
- C. Biological conditions
  - 1. Windblown spores and seeds
  - 2. Animal influences
    - a. transport seeds
    - b. excrement
  - 3. Humus
- D. Time
- E. Summary of soil formation

III. Soil Horizons
- A. O horizon
- B. A horizon
  - 1. Zone of removal
    - a. minerals and humus percolate downward
    - b. high organic content
  - 2. Topsoil

C. B horizon
1. Zone of accumulation
a. percolated minerals and humus
b. clay accumulation
2. Subsoil
D. Weathered parent material
E. Bedrock
IV. Soil Geography
A. Categories of parent material
1. Glacial drift
2. Igneous rocks
3. Sedimentary rocks
4. Alluvium
5. Loess
B. Northern Missouri soils
1. Thick loess near streams and rivers
2. Glacial drift
3. Loamy A horizon
4. Clayey B horizon
C. Southeastern igneous soils
1. Shallow soils
2. Many rock fragments
D. Southern Missouri soils
1. Sedimentary sandstone soils
2. Cherty limestone soils
3. Fragipan formation
E. Floodplain soils
1. Alluvium
2. Colluvium
F. Summary of soil distribution
V. Soil Conservation
A. Why conserve soils
B. Soil conservation practices
C. Cover crops and windbreaks
D. Crop plant methods
1. Crop rotation
2. Conservation tillage
E. Planting on the slope
1. Contour farming
2. Strip cropping
3. Terracing
F. Land use and soils
G. Soil conservation agencies

Introduction

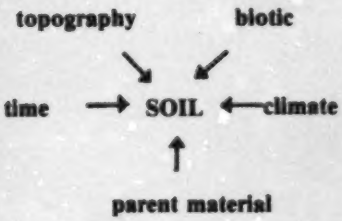
Purpose of the Instructional Unit

The purpose of this unit is to describe soil formation and distribution in Missouri and to generate a better understanding of this important resource. This unit does not attempt to provide detailed information on soil conservation, as those practices will be covered in a subsequent unit. However, some of the common soil conservation methods will be mentioned.

Soil is the outermost solid layer of the earth, and as such is the parent of all living things on the planet. The soil layer provides support and nutrients for the root systems of terrestrial plants, thus supporting animal and human life as well.

Protecting and improving the soil layer is soil conservation.

To understand the soil layer, one must first examine soil forming factors. After the soil forming processes are understood, distribution of soils can be comprehended. Soil conservation involves application of these understandings to protect and improve the soil layer.



Soil formation is affected by five principle factors. The first factor is the **parent material** which is altered by the **climate** factor. The extent of alteration is controlled by **topography** and **time** factors. The final variable is the **biotic** factor (Allgood and Persinger, 1979). The orderly distribution of soils developed by the soil forming process is soils geography. Protecting and improving the soil layer is soil conservation. Understanding these topics will accomplish the purposes of this guide.

Objectives of the Instructional Unit

The general objectives of this instructional unit are:

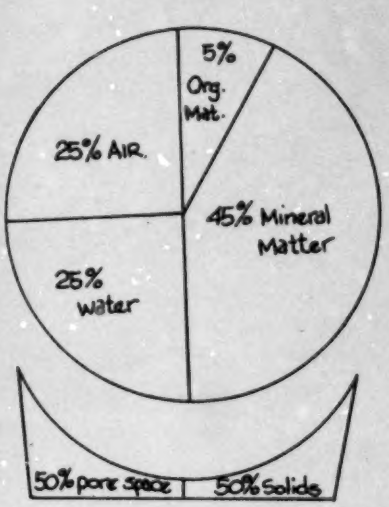
Each student should be able to:

1. Name the five soil forming factors.
2. Name the four materials which make up the soil.
3. Identify two chemicals which combine to form carbonic acid and how this aids in soil formation.
4. Write the definition of soil.
5. Explain how humus is formed.
6. Explain how the A and B horizons of a soil are formed.
7. Outline on a map of Missouri the five soil regions of the state and name the parent material for each region.
8. Explain three advantages of planting cover crops as a soil conservation practice.
9. State the importance of conservation tillage as a soil conservation practice.

Definitions of Soil

To the farmer, soil is a medium in which to grow crops. To the engineer, soil is a material to support building foundations or roads. To the average person, soil is the loose material on the

Soil is many things to different people.



earth's surface that supports and nourishes plants. To the scientist, soil is a naturally occurring mixture of minerals, organic matter, water and air which has definite structure and composition and forms on the surface of the land. Realizing that soil is all the above and more importantly, a basic substance upon which life depends, the conservationist is concerned with its needless loss to erosion.

The soil, regardless of how each person describes it, is important and should not be taken for granted. While soil is considered by many a renewable resource, it is only so if man does not interfere with its formation and if erosion is not a problem (some consider soil a nonrenewable resource because they feel that it does not naturally replenish itself within the limits of human time). In any case, soil formation is extremely slow, even under ideal conditions.

Thus the soil layer is made up of a mixture of minerals, organic matter, water and air. About one-half of the volume of the soil is pore space which is occupied by water when the soil is saturated and by air when the soil is completely dry (Millar, Turk and Foth, 1965).

The soil layer on the earth's surface changes continuously. A specific soil type is surrounded by other soil types and may occupy an area of less than 1 acre to more than 100 acres. The surface of the earth is the soil's upper limit. The lower boundary is more difficult to define, but is either the depth to which soil weathering has been effective or the bedrock. The boundary between adjacent soil types is usually gradual with one soil grading almost imperceptibly into the next. An exception to this gradual change occurs where there is an abrupt topographic change, such as along a steep bluff.

Soil Forming Processes

New landforms have the potential for soil formation.

Soil forming processes begin with newly created landforms such as a beach left high and dry by a drop in sea level, or a new volcanic cone produced by an eruption. From the time these new landforms emerge, they have the potential for soil formation.

They are made up of some parent material. In the case of the beach, the parent material is sand. In the case of the volcano, the parent material is volcanic ash.

These landform features also have topographic conditions. The beach is relatively flat while the volcano is steeply sloping.

Both landforms are immediately exposed to a particular climatic condition. Temperatures fluctuate daily and seasonally, causing thermal expansion and contraction that begins the alteration processes that change the parent materials into finer particles such as silts and clays. Precipitation adds water and the chemical breakdown of primary minerals is enhanced when the water combines with carbon dioxide from the atmosphere to form a weak acid

Carbon dioxide and water combine to form carbonic acid.

$$CO_2 + H_2O \rightarrow H_2CO_3$$

called carbonic acid.

The carbonic acid and water percolate through the pore spaces of the parent material, carrying with them dissolved minerals and newly formed clays. These minerals and clays begin to accumulate below the surface, initiating the process of soil formation.

While this movement of particles from surface to subsurface is taking place, the surface is being covered with plant life from wind-blown spores and seeds germinating on the new landform. Birds and mammals crossing the new landform have also dropped seeds or left them behind with their excrement, to germinate and increase the variety of plant life.

The plants stabilize the surface by anchoring the parent material in place with their root systems, thus prohibiting erosion. Plants and animals as biotic factors aid in the breakdown of parent material by supplying ingredients that hasten the chemical weathering process. Dead plant and animal material is broken down by microorganisms and other animals in the soil and becomes humus. Humus increases the soil's ability to hold water and to provide nutrients to plants.

The process of soil formation takes thousands of years.

The above description includes four of the five factors necessary for soil formation. The **parent material, topography, climate** and **biotic** factors all contribute to the process; however, the process takes time. How much time depends primarily on the type of parent material and climate and to a lesser degree on the topographic and biotic conditions. The age of a soil must be considered in thousands, even millions, of years since it may take hundreds of years for these factors to form one inch of topsoil. Thus, eroded soil cannot be replaced *quickly* by natural processes.

Soil develops in relationship to time.

In summary, soil formation results from the original parent material being altered by physical, chemical and biological weathering processes. The rates of weathering are controlled by the climatic condition and are usually faster in warmer, wetter climates than in colder, dryer climates. The topography also affects the rate of soil formation, with steeper slopes eroding faster than soil formation can occur, thus reducing soil development.

Soil Horizons

The soil is made up of layers called horizons. In a hypothetical soil profile, there are four horizons. The existence and thickness of each horizon varies in actual situations with location and soil use. While all four layers may be easily observed along a road cut, under certain conditions of construction or severe erosion from heavy agriculture, not all horizons will be observable.

The uppermost O horizon is a narrow zone lying on the surface consisting of leaf litter, detritus and other organic material. Because of decomposition, this horizon is a dark layer occurring on non-disturbed soils.

The A horizon is the zone of removal usually called topsoil. The B horizon is the zone of accumulation normally called subsoil.

Together they make up the true soil.

The physical, chemical and biological processes, aided by the movement of water down through the pore spaces of the A horizon, move materials such as iron, humus, calcium and clay to the B horizon where they accumulate.

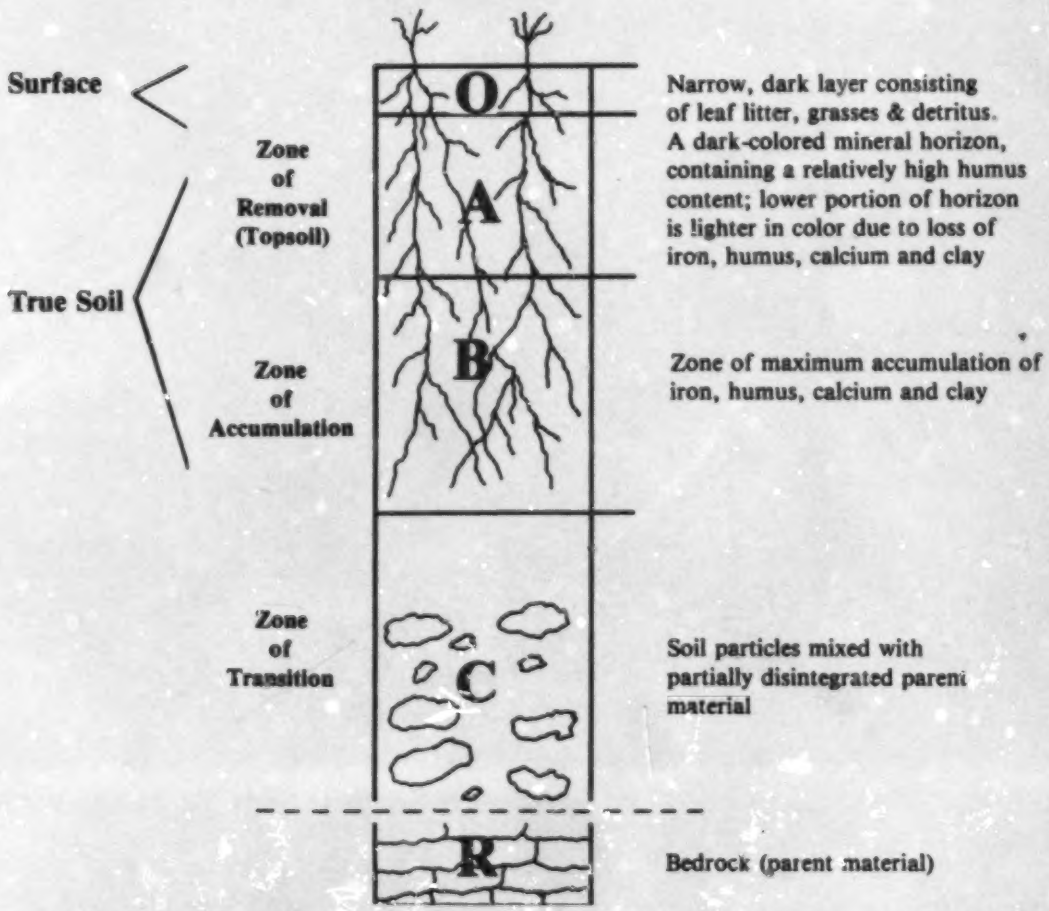
The relocation of these materials forms recognizable layers within the soil. Many Missouri soils contain B horizons with strong, dense, clay accumulations.

Another feature of some Missouri soils is an A horizon with a dark brown upper portion, resulting from the addition of organic matter by surface vegetation. This organic material becomes humus and gives the top few inches of the soil a darker color.

The C horizon is a transition area between soil and parent material. Minerals and other particles of soil are mixed among partially disintegrated parent materials.

The final horizon, the R horizon, is the bedrock. Because of its rock structure, this zone would not be included in a soil profile.

Figure 1: A Typical Soil Profile.


Surface
True Soil
Zone of Removal (Topsoil)
Zone of Accumulation
Zone of Transition
O
A
B
C
R
Narrow, dark layer consisting of leaf litter, grasses & detritus.
A dark-colored mineral horizon, containing a relatively high humus content; lower portion of horizon is lighter in color due to loss of iron, humus, calcium and clay
Zone of maximum accumulation of iron, humus, calcium and clay
Soil particles mixed with partially disintegrated parent material
Bedrock (parent material)

The depth of the A and B horizons and the amounts and kinds of materials contained in them provide an endless variety of combinations. Soils with similar characteristics of parent material horizon development are grouped together and identified with a soil series name which allows them to be mapped.

The second section of this instructional unit addresses the soils geography of Missouri, the distribution of soils covering the surface of the state.

Soils Geography of Missouri

Allgood and Persinger (1979) have published a general soil map of Missouri with soil association descriptions. This publication is available from the United States Department of Agriculture, Soil Conservation Service State Office in Columbia, Missouri. This instructional unit does not intend to duplicate their publication but to condense and simplify their information.

Categories of Parent Material

In general, there are five categories of parent material in Missouri from which soils have formed.

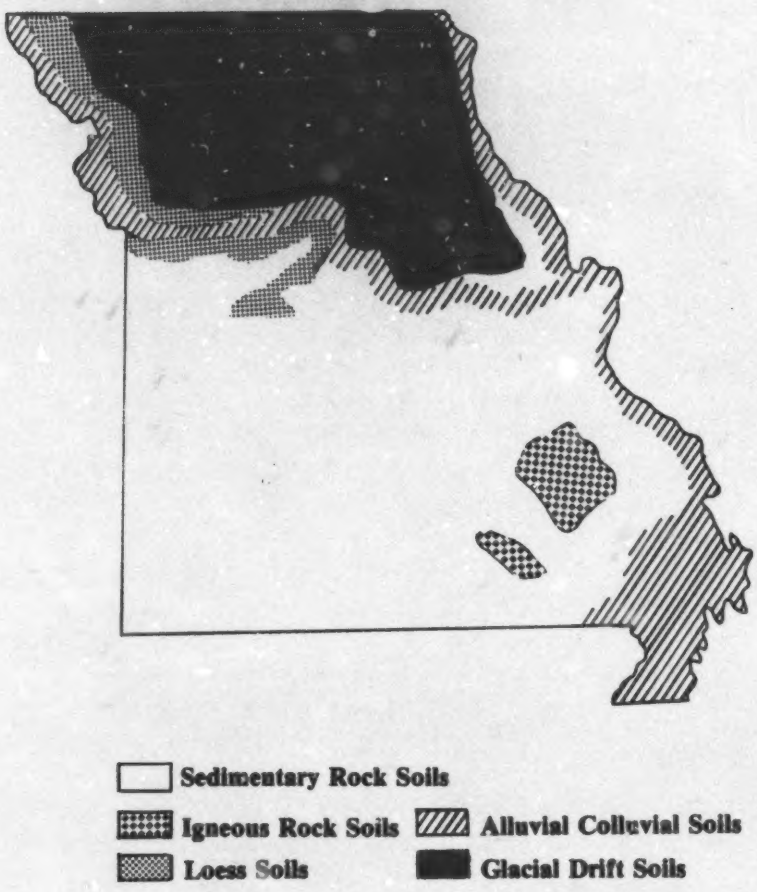
Pleistocene glacial deposits, called drift, cover the surface in northern Missouri. Igneous rocks provide the parent materials for soils in the St. Francois Mountains region of southeastern Missouri. The sedimentary sandstones, shales, limestones and dolomites surrounding this igneous dome comprise the surface materials of most of the southern half of Missouri.

All of the valleys in the state that are large enough to have a river with a floodplain contain the fourth parent material, valley alluvium and colluvium. The Bootheel of southeastern Missouri is covered with Mississippi River alluvium.

Loess is the last parent material of significance and knows no boundaries. Loess is a windblown silt transported and deposited extensively during the interglacial periods of the Pleistocene Epoch and can be found on ridge tops and in valleys throughout the state. Thick blankets of loess cover many areas of northern Missouri, particularly along the eastern and northern side of the Missouri River in northwest Missouri.

Figure 2 illustrates the five major soil areas of Missouri based on parent material. Keep in mind that all of the regions have areas with a loess parent material.

Figure 2:
Generalized Soil
Regions of Missouri



Northern Missouri Soils

Deep loess deposits are found along rivers in northwest Missouri.

The soils in northern Missouri have formed in deep loess or in a thin layer of loess which overlies glacial till. The deep soils are found as thick loess deposits along the bluffs of larger streams and rivers. These are usually deep, well-drained, loamy textured soils with good fertility. The ridge tops of these bluffs are broad and flat and the valley sides are steeply sloping.

As you move away from the larger streams in northern Missouri, the loess thins and glacial drift becomes the dominant surface parent material. Northern Missouri is dominated by soils with a two-storied parent material composed of thick deposits of glacial drift covered with a thin layer of loess. There are some soils formed only in glacial drift and most of these occur on the back slopes of hillsides where the loess has been removed by erosion. The soils that

have formed in the two-parent materials are loamy in the A horizon and clayey in the B horizon. A large area of northeastern Missouri is classified as a claypan soil area because soil development has produced a thick layer of clay in the B horizon, reducing permeability and resulting in poor drainage.

The topography of northern Missouri is rolling to hilly in general but becomes flat in the claypan area. The valley slopes are relatively steep but give way to nearly level areas in the valley bottomlands. The landscape is covered by fields of soybeans, corn, milo and hay.

Southeastern Missouri Soils

The igneous rocks of southeastern Missouri have developed into a steeply sloping, mountainous terrain. Shallow soils containing many stones and boulders are common. Some areas, like Elephant Rocks State Park, have no soil layer at all. Soils forming here have a bouldery, silt loam A horizon overlying a silt loam or clay loam subsoil containing many rock fragments. These soils are not suitable for cultivation and are covered with oak-hickory forests.

Southern Missouri Soils

The sedimentary rocks of the remainder of the southern half of Missouri have formed soils exhibiting the characteristics of their parent materials. For example, soils formed from weathering sandstone have a sandy texture whereas soils formed from shale have a clayey texture.

The dominant sedimentary rock material of the Ozarks is cherty limestone.

Clayey soils are also formed from the dominant sedimentary rock material of the Ozarks, cherty limestone. Soils formed in this parent material are different from shale clays because they contain a high percentage of chert that remains as rock fragments after the limestones weather to clays. The accumulated clays in the B horizons are frequently underlain by a fragipan. This dense layer restricts root penetration and therefore stunts tree growth. The fragipan layer is a less clayey zone that is comprised of chert and silt-sized particles.

The topography of the Ozarks is highly variable. The flatter ridge tops and valleys are cultivated, with gentle slopes in pasture and steep slopes dominated by oak-hickory forests.

Floodplain Soils

Reworked loess has been transported by running water.

All of Missouri's major streams have valley bottomlands of alluvium and colluvium. The alluvium was deposited by the streams themselves whereas the colluvium was washed into the valleys from the hill slopes. Much of the valley colluvium is loess which was eroded from the slopes of adjacent valley sides. This colluvium is called reworked loess because it was transported by running water to the valley floor.

Soils formed in the floodplain are deep with loamy, sandy or clayey characteristics. They usually have clayey B horizons and are poorly drained. The topography is very flat and most of the area is under cultivation. Floodplain crops include corn, soybeans and milo with the addition of cotton and rice in the Bootheel.

Summary

In summary, the general distribution of soils in Missouri is based on the types of parent materials and their locations. Glacial till soils dominate the northern part of the state while sedimentary rock soils are found in the southern half. Igneous rock soils are located in the St. Francois Mountains region and alluvial-colluvial soils are found along major streams. In addition, most of the soils of Missouri have been affected by loess deposition.

Soil Conservation

Protecting and improving the earth's soil layer while still using it for production of food and fiber is soil conservation. Practices which protect the soil usually help keep it in place. Practices which improve the soil generally increase its fertility and/or water-holding capacity.

Why Conserve Soils

While the world relies upon the Middle East for petroleum energy resources, it more and more looks towards North America as the "breadbasket" of agricultural "food and fiber" production. The United States, with its wealth of productive soils and advanced agricultural technology, has traditionally answered the call. The United States is the leading exporter of agricultural products, and food constitutes about one-third of its foreign aid. Combined with foreign aid and export trade, domestic use—that provides American citizens one of the highest standards of living in the world—requires the maintenance of a very high soil productivity.

This high productivity has been achieved at a cost. The United States is literally "mining" its soils. The quality of soils has paid the price as decreased amounts of humus and fertility and increased erosion result from intensive production. In order to maintain the high standard of living in the United States, as well as world exports, soil conservation practices must be applied to the land.

Soil must be conserved for other than economic reasons. Pure drinking water and clean air directly depend on proper soil use. Wind erosion of unprotected soils foul the air (read John Steinbeck's book, *Grapes of Wrath*, to learn about the American Dust Bowl Days of 1930's). Watersheds and the water quality of the streams and rivers they supply depend directly upon soil conservation.

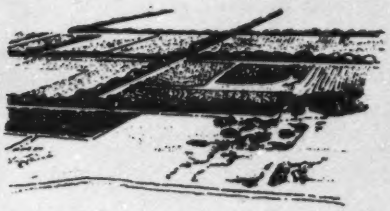
Most conservationists believe that man, as a user of natural resources, has a responsibility to manage those resources to assure adequate supplies for future generations. Soil Stewardship Week is an annual event beginning with the fifth Sunday after Easter and continuing through the sixth, sponsored by the National Association of Conservation Districts (NACD) to add to public awareness of man's responsibility. (Soil Stewardship Week materials are available by early request from the local Soil and Water Conservation Districts, located in most Missouri counties and for a small fee from the NACD, 408 East Main, P.O. Box 855, League City, Texas 77573.)

In addition to the above, soil should be conserved simply for aesthetic reasons. Most people prefer visual experiences of naturally-appearing landscapes to those of a land full of the unsightly scars due to erosion and land use abuses.

Soil Conservation Practices

Soil conservation practices vary with land use. In rural areas primary concern is with controlling agricultural erosion. In urban environments the practices generally apply to controlling erosion and runoff water around construction sites. Many soil conservation applications are as simple as selecting proper plantings. Other mechanical practices, while cost-prohibitive for the landowner in the short-term, must be implemented to guarantee long-term productivity of the soil.

Cover crops and windbreaks



The use of cover crops is one of the simplest conservation practices. By maintaining a plant cover of grasses and other close-growing plants on the soil surface, both water and wind erosion are slowed or prevented. Native grasses used as cover crops can also be used as forage and are especially durable during periods of drought, which frequent Missouri during summer. Cover crop plantings that include legumes such as alfalfa and clover also serve as forage for livestock. These legumes contain nodules of nitrogen fixing bacteria in their roots. The nodules convert atmospheric nitrogen to nitrates usable by plants for growth, and they improve the fertility of the soil. When plowed under, legumes add organic material to the soil and improve tilth.

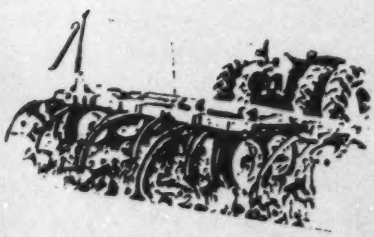
Windbreaks of tall native grasses or thick trees and shrubs can be planted on crop field edges to reduce wind speed. This plant cover buffers the effects of the wind on adjacent crop fields whose soils are normally exposed after harvest in the fall, particularly important if fall plowing is routinely practiced.

Crop Plant Methods

Crop rotation and conservation tillage are fairly simple methods of conservation planting. Crop rotation is the annual alternation of crops in a field to prevent nutrient loss and depletion. Often row crops are rotated with legumes or pastures to take full advantage of nitrogen fixation and nutrient buildup.

Crop Rotation

Conservation Tillage



Conservation tillage is a method of row cropping in which the harvest removes only the grain and leaves the remaining parts of the plant on the soil. This practice provides a mulch cover on the soil during the off season, thus reducing wind and water erosion.

Conservation tillage can vary from no-tillage planting into sod or previous crop residue, to minimum tillage which involves minimum turnover of field soil before planting. Since the land is not conventionally plowed, conservation tillage results in fewer tractor

trips across the field, reducing soil compaction and time and energy expenses. However, the method may require more herbicide use to kill out existing sod or reduce weed growth normally eliminated by cultivation.

Planting on the Slope

Erosion of soil slopes can be prevented by using methods that slow the speed of water as it moves down hillsides. While the use of mulch and cover crops usually reduces the erosion potential of building sites in urban areas, rural lands kept in agricultural production must use other conservation methods.

Contour Farming

The simplest, contour farming, places crop plantings parallel to hillsides, along the contour rather than up and down the slopes. Each furrow made by the mechanical planter acts as a small, continuous dam to slow the path of runoff water and prevent erosion.

Strip cropping

On land with a decided slope, planting crops in strips or bands with the contour is an effective erosion deterrent. Row crops such as corn, soybeans, or milo are often alternated along the contours into curving belts of a cover crop of hay grasses and legumes.

Terracing

Terracing involves the mechanical, often expensive, construction of several embankments of earth, one above the other, to control water flow and minimize erosion. Terraces must be placed close enough to check water flow before its velocity becomes sufficient to dislodge and transport soil. Accumulated water is usually transported along each terrace at gentle flow and transported into a suitable grassed waterway or natural controlled gully. Crops are planted along the terraces.

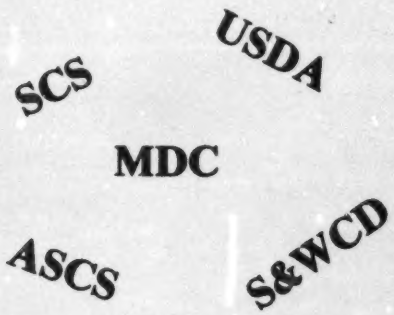
The above discussed practices are by no means the only answers to soil conservation. Combinations of these and other methods should be included in the agricultural operation or construction plan.

Land Use and Soils

Perhaps more important than after the fact, stopgap practices of soil conservation, the goal of any land use planner, developer, or landowner should be to match the use of the land with soil type. Not all soils are suitable to agriculture. Not all soils provide optimal sites for roads, factories, or homes. Soil surveys of most Missouri counties—complete with information on proper uses of various types—are now available for examination at local Soil Conservation Service offices.

Land use practices must also be placed under increased scrutiny. Because prime farmland with rich soils is often flat and well-drained, it is often perfect for development. Some of the most productive crop land in Missouri and the nation is being lost to the urban sprawl of housing developments, industrial parks, shopping malls, airports and reservoirs. As shrinking prime agricultural and recreational acres are called upon to feed and clothe an increasing world and United States population, the loss of this valuable resource may lead to new thoughts on the necessity of land-use planning.

Soil Conservation Agencies



Several cooperating agencies have the primary responsibility for helping Missourians manage soil resources. The Soil Conservation Service (SCS) of the United States Department of Agriculture has local offices located in almost all Missouri counties. Another USDA agency, the Agricultural Stabilization and Conservation Service (ASCS), provides cost-sharing to landowners for conservation work done on their lands. Local Soil and Water Conservation Districts are now viable conservation units in 111 of 114 counties. Organized and governed on the local level, they work closely with soil conservation service personnel to help identify and solve local soil conservation problems.

The Missouri Department of Conservation works closely with landowners and soil conservation agencies to establish wildlife habitat and forest management practices on erodible soils. More recently, the Department of Conservation has placed a high priority on cooperating with the SCS, ASCS and S&WCD's to increase public awareness of soil problems and to decrease the rate of erosion of Missouri's vital soil resource.

"Hold in your mind the memory of the land as when you take it. And with all your strength, with all your mind, with all your heart, preserve it for your children and love it..."

(Chief Seattle, Duwamish Indian)

Lesson Plan No. 1

TITLE: Soil Formation

MATERIALS: Transparency: Soil Materials, Appendix 1. Crossword Puzzle: Conservation Soil Toiler, Appendix 2.

OBJECTIVES: After completing the lesson, the students should be able to:

1. Name and describe the five soil forming factors.
2. Identify the four components which make up the soil.
3. State the percentage of the soil volume that is pore space.
4. Identify two chemicals which combine to form carbonic acid and describe how this aids in soil formation.
5. Write the definition of soil.
6. Explain how humus is formed.

METHOD: Lecture and discussion

PROCEDURE:

I. Introduction
   A. How is soil important to the following professional technicians?
      1. Architect
      2. Farmer
      3. Pond builder
      4. Road construction foreman
   B. How is soil important to the conservationist?

II. Presentation
   A. Soil forming factors
      1. Parent material
      2. Topography
      3. Climate
      4. Biotic factors
      5. Time
   B. Components which make up the soil
      1. Minerals
      2. Organic matter
      3. Water
      4. Air
   C. Pore space in soil volume
      1. Fifty percent of soil volume
      2. Air and water content
   D. Soil forming processes
      1. Physical
         a. Temperature change
         b. Weathering of parent material
      2. Chemical
         a. Precipitation
         b. Carbonic acid
            (1) Formed from water and carbon dioxide

(2) Percolates through parent material
c. Accumulation of minerals and clays
3. Biological
a. Root systems stabilize soil
b. Supply additional chemicals
c. Humus
(1) Formed by decomposition of organic materials
(2) Enhances water holding capacity of soil

E. Soil defined (SCS definition):
A naturally occurring mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of land.

III. Summary
A. Alteration of parent material
B. Problem of erosion
C. Conservation soil toiler

Lesson Plan No.2

TITLE: Soil Geography of Missouri

MATERIALS: Transparency: Soil Geography of Missouri, Appendix 3. Soil monolith (if available on loan from local Soil Conservation Service office or soil horizons can be examined in road cuts or other excavated site)

OBJECTIVES: After completing the lesson, the students should be able to:
1. Explain how A and B soil horizons are formed.
2. Outline the five soil regions of Missouri and identify the parent material for each region.
3. Describe the parent material of the soil in your area of Missouri and name the plants/crops which it supports.
4. Explain why soil is considered a slowly renewable resource.

METHOD: Lecture and discussion

PROCEDURE:

I. Introduction
A. Show class one or more soil monoliths (if available or take field trip to road cut or other excavation site)
B. Cite differences in their appearances

II. Presentation
A. Soil horizon formation
1. A Horizons
a. Zone of removal
b. Dissolved minerals percolate downwards
c. High humus content
2. B Horizons
a. Zone of accumulation

b. Concentration of minerals
c. Dense dark clay deposits
d. Also called subsoil

B. Regional parent materials
1. North glacial drift soils
2. Southeast igneous rock soils
3. South sedimentary rock soils
4. Floodplain alluvial-colluvial soils
5. Statewide loess soils

C. Emphasis on local region
1. Description of parent material
2. Plant associations

D. Soil
1. Renewable resource
2. Thousands of years to form from parent material

III. Summary
A. Soil characteristics can be mapped, charted and classified
1. Location
2. Texture
3. Color

B. Deserves more attention
1. Covers the earth
2. All life depends on the soil

Lesson Plan No. 3

TITLE: Soil Conservation

MATERIALS: Film: *Farming with Nature* (obtain from Missouri Department of Conservation personnel)

OBJECTIVES: After completing the lesson, the students should be able to:
1. Name three ways soil conservation improves the soil.
2. Identify three advantages of planting legume cover crops as a soil conservation practice.
3. State the primary reason for conservation tillage.
4. Name three other soil conservation practices.

METHOD: Lecture, discussion and film

PROCEDURE:

I. Introduction
A. Thousands of years to form soil from parent material
B. 100 or more years to make an inch of topsoil
C. One year for erosion to destroy one-fourth inch of topsoil

II. Presentation
A. Soil conservation
1. Protecting soil
a. Keeping soil in place

b. Agents of erosion
2. Improving the soil
a. Increasing fertility
b. Increasing water holding capacity

B. Advantages of planting cover crops/legumes
1. Nitrogen-fixing nodules improve fertility
2. Plowing under increases water holding capacity
3. Plowing under restores organic material increasing fertility

C. Crop rotation

D. Advantages of conservation tillage
1. Less expensive
2. Fewer tractor trips across field
3. Less time spent cultivating
4. Reduces compaction of land
5. Energy conservation
6. Smaller equipment

E. Mechanical soil conservation practices
1. Contour plowing
2. Strip cropping
3. Terracing
4. Grassed waterways

III. Summary

A. Connection to soil

B. Precious resource

Glossary

alluvium: soil deposited by streams.

bouldery: adjective often used in soils description jargon to describe soils containing rock fragments where the stones are larger than 24 inches.

chert: a very fine-grained, tough rock composed mainly of silica and occurring commonly in limestone beds.

clay: mineral particles smaller than 0.002 mm diameter that compose the soil and give it texture; cannot be seen with unaided eye and are the most reactive mineral ingredients in soil.

claypan: a compact, slowly permeable soil horizon commonly hard when dry and plastic or stiff when wet, formed by downward movement of clay or by synthesis of clay during soil formation. They usually impede movement of water and air, and the growth of plant roots.

colluvium: soil deposited when washed into the valleys from hill slopes.

detritus: disintegrated matter, such as organic debris or rock fragments, accumulated on soil, mud, or in pond water.

dolomite: a magnesia-rich sedimentary rock [$CaMg(CO_3)_2$] resembling limestone, often occurring in extensive beds.

fragipan: dense, compact clay layer in the subsoil that is very slowly permeable to water. Usually has an abrupt upper boundary and is hard or very hard when dry and plastic and sticky when wet. It may be found in profiles of either cultivated or virgin soils, but not in calcareous material.

glacial drift: rock debris transported by glaciers and deposited directly by the glaciers or from the meltwater.

horizons: zones of soil formation found in layers.

humus: soil organic matter remaining after plant and animal residues are decomposed.

igneous rock: rock produced through the cooling of melted mineral matter.

landform: a discernible natural landscape that exists as a result of geological activity, such as a plateau, plain, basin, mountain or the like.

limestone: a sedimentary rock composed of calcium carbonate ($CaCO_3$).

loam: a rich soil that contains 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand, and some organic matter.

loess: windblown and deposited silt.

minimum till planting: soil conservation practice of planting crops into soils that have been disturbed less than by conventional plowing practices; saves topsoil by preventing erosion.

no-till planting: soil conservation practice of planting crops directly into sod or previous crop residue; saves topsoil by preventing erosion.

parent material: the unconsolidated mineral or organic material from which the soil profile develops through soil formation processes.

Pleistocene Epoch: covering the period between 600,000 and 12,000 years ago and was characterized by the spreading and recession of continental ice sheets and by the appearance of modern man.

Pleistocene glacial deposits: soil deposited when glaciers passed over the land during the Pleistocene Epoch.

pore space: total space in a volume of soil not occupied by soil particles.

sand: mineral particles ranging in diameter from 2 mm to 0.05 mm that compose the soil and give it texture; are easily seen with the unaided eye, and feel gritty.

sandstone: a common sedimentary rock composed largely of sand grains, mainly quartz, cemented together by various binding materials such as silica.

shale: stratified sedimentary rock structure, generally formed by the consolidation of clay or clay-like material.

silt: mineral particles ranging in diameter from 0.05 mm and 0.002 mm that compose the soil and give it texture; to the touch, resembles feel of flour.

soil: a naturally occurring mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of the land.

soil survey: the identification, classification, mapping, interpretation and explanation of the soil over a given area of land.

till: unstratified glacial drift deposited directly by the ice and consisting of clay, sand, gravel and boulders intermingled in any proportion.

tilth: the physical condition of soil as related to its ease of tillage, fitness as a seed bed and impedance to seedling emergence and root penetration.

topography: the surface features of a region including its relief, rivers, lakes and such man-made features as canals, bridges, roads, etc.

watershed: all land and water within the confines of a drainage divide that drains into a single given point, stream, or stream system.

weathering (process): the decomposition and disintegration of earth materials and rocks through exposure to weather to form soil.

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Columbia, MO 65202

University of Missouri Extension Service (local office in many towns & cities)
Department of Agronomy
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Columbia, MO 65211

Missouri Department of Natural Resources
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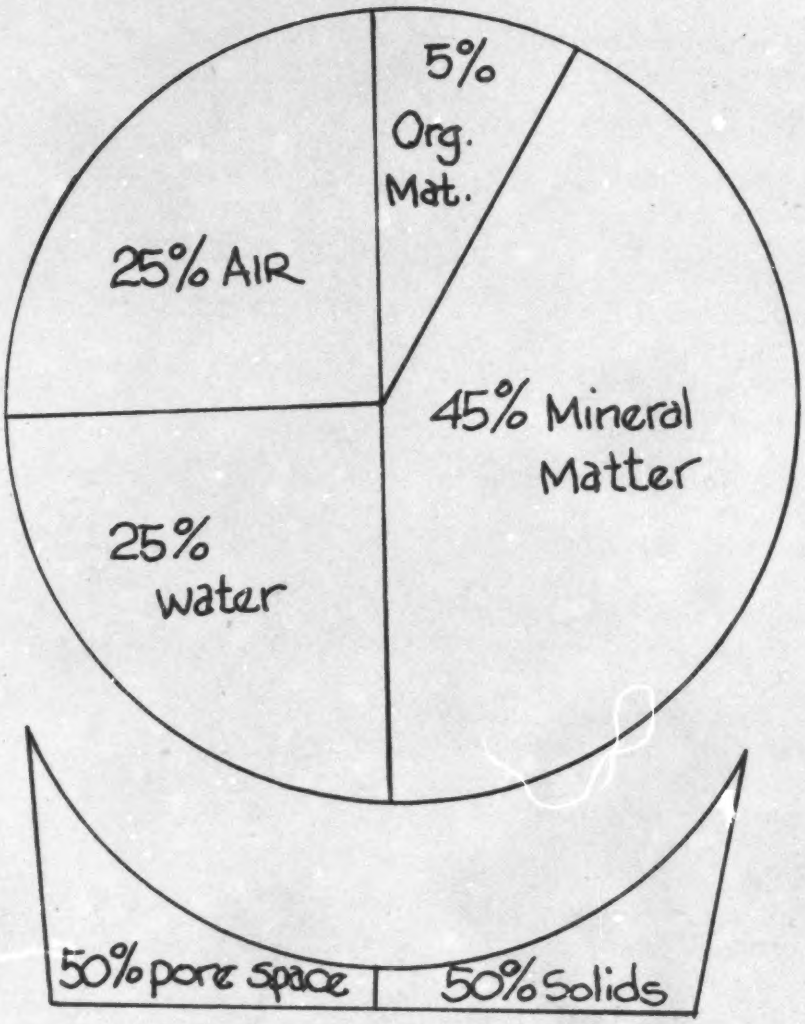
Soil and Water Conservation District
(local district usually located in SCS County Office by county name)

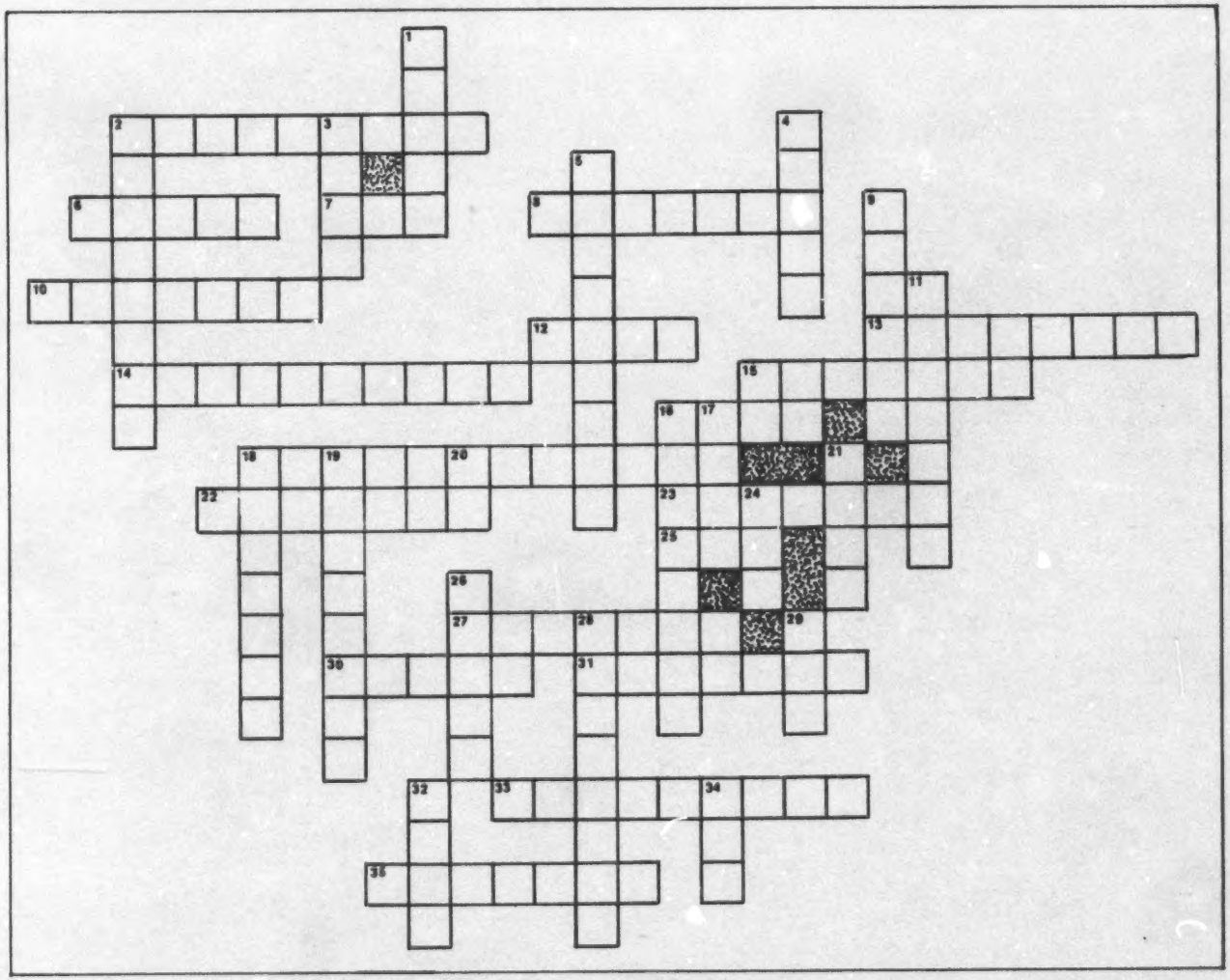
The following slide sets can be purchased from:
State Fair Community College
Media Center
1900 Clarendon Road
Sedalia, MO 65301

Introduction to Soils
The Soil Profile
Composition of Soil
Soil Separates and Texture
Soil Color
Legal Land Description and Soil Survey

Soil Materials



Conservation Soil Toiler



Conservation Soil Toiler

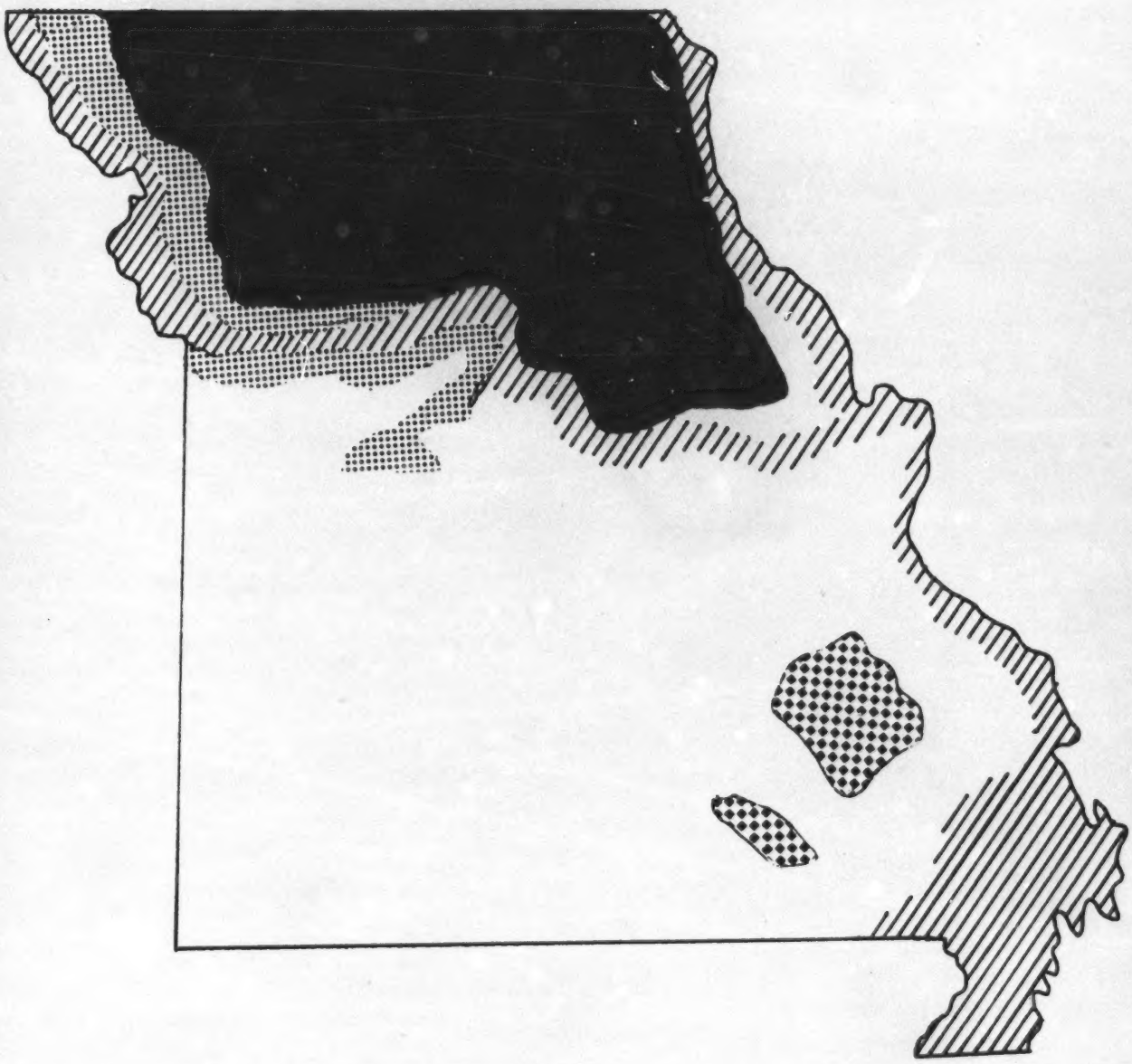
ACROSS

2. A living barrier of trees, shrubs, or tall annual crops planted to serve as protection from wind erosion.
6. Percent of deviation of a surface soil from the horizontal.
7. A groove or track gouged into the ground by the passage of wheeled vehicles.
8. Clayey soil beneath the topsoil.
10. Plants can obtain it from lime added to the soil.
12. Minute mineral particles that compose soil and resembles the feel of flour.
13. Organic debris accumulated on soil, mud, or pond water.
14. Substance that farmers add to soil which provides essential plant nutrients.
15. An inorganic substance needed by plants and animals for growth.
16. French for "please reply" (abbr.).
18. The wise use of soil and natural resources so that man will always have them to use.
22. Usually a cone-bearing evergreen tree.
23. The most fertile layer of soil.
25. A mixed feeling of reverence, fear and wonder.
27. The remains of plants and animals is called "____ matter."
30. A channel cut by water runoff during and immediately after heavy rains and melting snows.
31. The loss of soil through the action of running water or wind.
33. All land and water that drains into a single stream.
35. Zone of soil formation found in layers.

DOWN

1. To put seed into the soil to grow.
2. Animals and plants of Missouri that live without being domesticated.
3. Scarce.
4. A layer of plant material on the soil surface to protect the soil.
5. Substances needed by plants and animals for proper growth.
9. Piece of land for growing plants and vegetables.
11. Soil containing proper kinds and amounts of nutrients which cause healthy plant growth.
16. Different crops planted in succession on the same piece of soil is called "crop ____."
17. Frozen water vapor that falls to earth as white crystal-like flakes.
18. Soil plowed across the slope to reduce erosion is called "____ farming."
19. A gas which comprises the mineral nitrates that are needed for plant leaf growth and green color.
20. Abbreviation for railroad.
21. The layer of mineral and organic material on the surface of the earth in which land plants grow.
24. If a wild animal is made into one it will not be able to take care of itself.
26. A foolish action.
28. The passage of oxygen and other gases through the soil.
29. The surface of grassland which contains roots of grass and other organic matter.
32. A small piece of ground.
34. Abbreviation for Soil Conservation Service.

Soils Geography of Missouri



Sedimentary Rock Soils

Igneous Rock Soils

Alluvial Colluvial Soils

Loess Soils

Glacial Drift Soils

Appendix 4

BEST Objectives Covered by this Instructional Unit

Reading/Language Arts

12. Follow a set of written directions.
13. Interpret information presented in graphic or pictorial manner.
14. Speak and write effectively in different social and business situations and with persons of varied ages or backgrounds.
15. Write with complete sentences, acceptable sentence structure, acceptable grammatical construction and correct spelling and punctuation.
17. Recognize the main idea and specific details in an oral presentation.
21. Follow oral or written directions to complete a process.

Mathematics

8. Interpret information from charts, graphs, tables, maps and scale drawings.

Government/Economics

7. Understand basic factors related to the production of goods and services.
8. Understand and be able to apply basic information about how private business functions in the United States.
10. Predict how one change in the economy will result in other changes.

Soil Formation and Distribution in Missouri

Test Questions

1. List the five soil forming factors.

2. What are the four components which make up soil?

3. Name two chemicals which combine to form carbonic acid.

4. What percent of soil volume is pore space? ____%

5. Write the definition of soil.

Match the soil parent material with its location.

____ 6. Northern Missouri	A. igneous rocks
____ 7. Southern Missouri	B. sedimentary rocks
____ 8. Bootheel and rivers	C. loess
____ 9. St. Francois Mountains	D. alluvium-colluvium
____10. Statewide	E. glacial till

True-False

____11. The A horizon is the zone of accumulation.
____12. Humus is formed when microorganisms break down organic materials.
____13. The B horizon has a high humus content.
____14. Soil is considered a renewable resource.
____15. Minerals and clays accumulate in the B horizon.
____16. The A and B horizons are considered true soil.
____17. The zone of organic enrichment is found at the boundary of the A and B horizons.
____18. Humus enhances the water-holding capacity of the soil.

19. Identify the parent material of the soil in your local area and name two plants or crops which it supports.

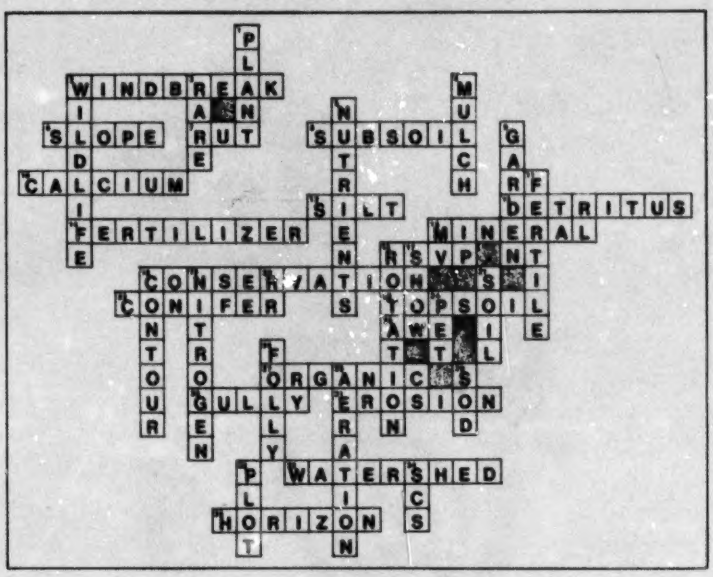
20. List three advantages of planting legumes as a cover crop.

21. What is the primary reason for conservation tillage?

Appendix 6

Answer Keys

Conservation Soil Toiler



Test on Soil Formation and Distribution in Missouri

1. Parent material, climate, topography, biotic and time.
2. Minerals, organic matter, water and air.
3. carbon dioxide and water
4. 50%
5. A naturally occurring mixture of minerals, organic matter, water and air which has a definite structure and composition and forms on the surface of the land (the mineral and organic matter that supports plant growth on the earth's surface).

6. E
7. B
8. D
9. A
10. C
11. F
12. T
13. F
14. T
15. T
16. T
17. F
18. T
19. Answers will vary according to region.
20. Legumes add nitrogen to the soil, add organic material and improve water-holding capacity if plowed under and when used as a cover crop to prevent erosion.
21. Reducing soil erosion.

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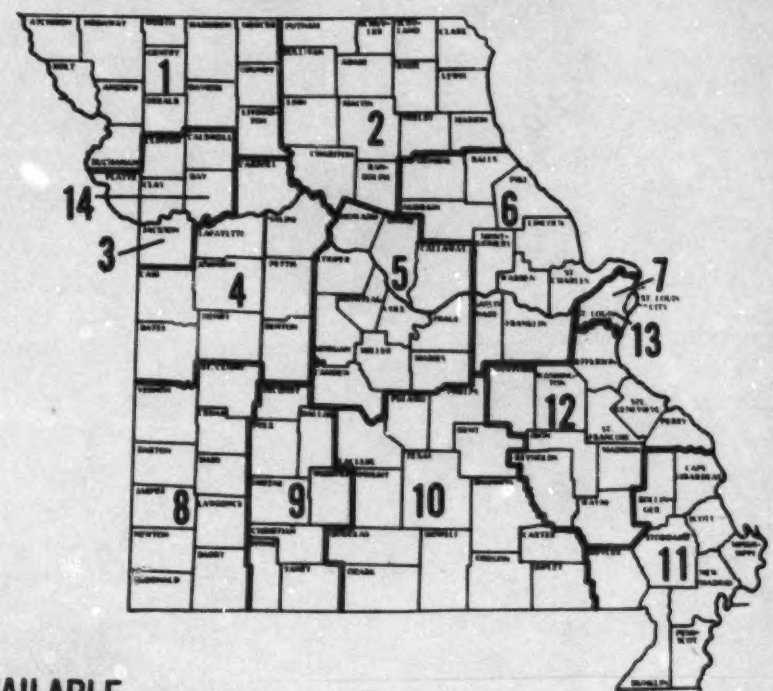

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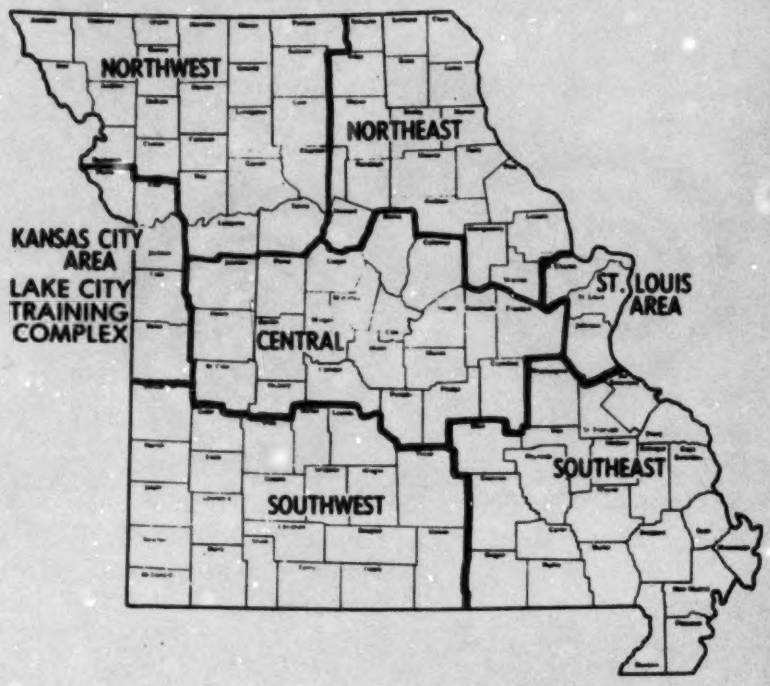

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NOTES: